

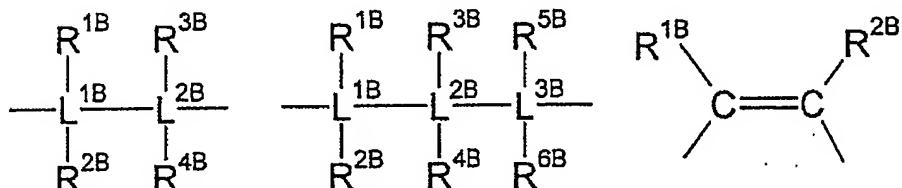
We claim:

1. A monocyclopentadienyl complex which contains the structural feature of the formula $(Cp)(-Z-A)_mM$ (I), where the variables have the following meanings:

5

Cp is a cyclopentadienyl system,

Z is a bridge between A and Cp and is selected from the group consisting of



10

where

$L^{1B}-L^{3B}$ are each, independently of one another, carbon or silicon,

15

$R^{1B}-R^{6B}$ are each, independently of one another, hydrogen, C_1-C_{20} -alkyl,

C_2-C_{20} -alkenyl, C_6-C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{7B}_3 , where the organic radicals $R^{1B}-R^{6B}$ may also be substituted by halogens and two geminal or vicinal radicals $R^{1B}-R^{6B}$ or a radical $R^{1B}-R^{6B}$ and A may also be joined to form a five- or six-membered ring and

20

R^{7B} are each, independently of one another, hydrogen, C_1-C_{20} -alkyl,

C_2-C_{20} -alkenyl, C_6-C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{7B} may also be joined to form a five- or six-membered ring,

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A is an unsubstituted, substituted or fused, heteroaromatic ring system,

M is a metal selected from the group consisting of titanium in the oxidation state 3, vanadium, chromium, molybdenum and tungsten and

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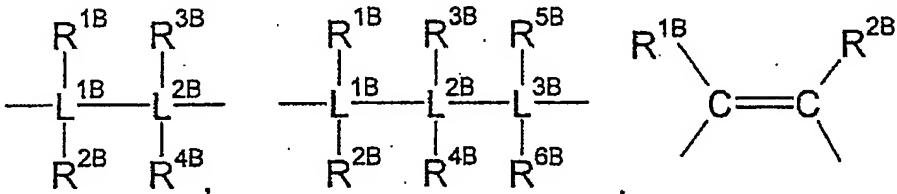
m is 1, 2 or 3.

2. A monocyclopentadienyl complex as claimed in claim 1 of the formula $(Cp)(-Z-A)_mMX_k$ (V), where the variables have the following meanings:

Cp is a cyclopentadienyl system,

Z is a bridge between A and Cp and is selected from the group consisting of

5



where

L^{1B} - L^{3B} are each, independently of one another, carbon or silicon,

10 R^{1B} - R^{6B} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{7B}₃, where the organic radicals R^{1B}-R^{6B} may also be substituted by halogens and two geminal or vicinal radicals R^{1B}-R^{6B} may also be joined to form a five- or 15 six-membered ring and

20 R^{7B} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{7B} may also be joined to form a five- or six-membered ring,

A is an unsubstituted, substituted or fused, heteroaromatic ring system,

25 M is a metal selected from the group consisting of titanium in the oxidation state 3, chromium, molybdenum and tungsten,

m is 1, 2 or 3,

30 X are each, independently of one another, fluorine, chlorine, bromine, iodine, hydrogen, C₁-C₁₀-alkyl, C₂-C₁₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having 1-10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR¹R², OR¹, SR¹, SO₃R¹, OC(O)R¹, CN, SCN, β -diketonate, CO, BF₄⁻, PF₆⁻ or a bulky noncoordinating anion,

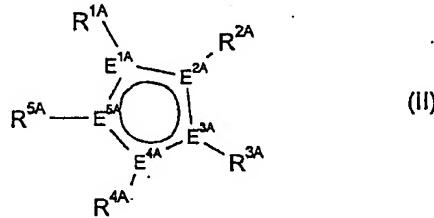
R^1-R^2 are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, SiR³, where the organic radicals R¹-R² may also be substituted by

5 halogens and two radicals R¹-R² may also be joined to form a five- or six-membered ring,

R^3 are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals 10 R³ may also be joined to form a five- or six-membered ring and

k is 1, 2 or 3.

15 3. A monocyclopentadienyl complex as claimed in claim 1 or 2, wherein the cyclopentadienyl system Cp has the formula (II):



where the variables have the following meanings:

$E^{1A}-E^{5A}$ are each carbon or not more than one E^{1A} to E^{5A} is phosphorus,

20 $R^{1A}-R^{5A}$ are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A},₂, N(SiR^{6A})₂, OR^{6A}, OSiR^{6A}, SiR^{6A}, BR^{6A}, where the organic radicals

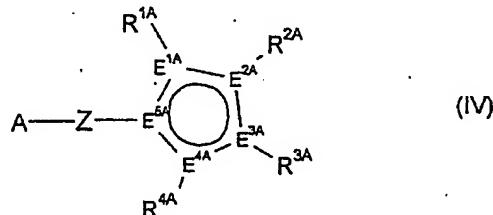
25 $R^{1A}-R^{5A}$ may also be substituted by halogens and two vicinal radicals $R^{1A}-R^{5A}$ may also be joined to form a five- or six-membered ring, and/or two vicinal radicals $R^{1A}-R^{5A}$ are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O and S, and where 1, 2 or 3 substituents $R^{1A}-R^{5A}$ is a group -Z-A and

30 R^{6A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl radical and 6-20 carbon atoms in the aryl radical and two geminal radicals R^{6A} may also be joined to form a five- or six-membered

ring.

4. A monocyclopentadienyl complex as claimed in any of claims 1 to 3, wherein the cyclopentadienyl system Cp together with -Z-A has the formula (IV):

5



where the variables have the following meanings:

E^{1A}-E^{5A} are each carbon or at most one E^{1A} to E^{5A} is phosphorus,

10

R^{1A}-R^{4A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A}₂, N(SiR^{6A}₃)₂, OR^{6A}, OSiR^{6A}₃, SiR^{6A}₃, where the organic radicals R^{1A}-R^{4A}

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may also be substituted by halogens and two vicinal radicals R^{1A}-R^{4A} may also be joined to form a five- or six-membered ring, and/or two vicinal radicals R^{1A}-R^{4A} may be joined to form a heterocycle containing at least one atom from the group consisting of N, P, O and S,

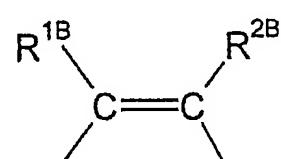
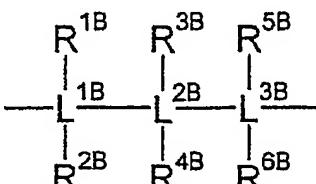
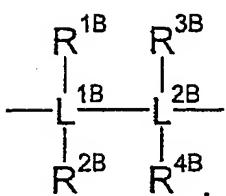
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R^{6A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{6A} may also be joined to form a five- or six-membered ring.

25

A is an unsubstituted, substituted or fused, heteroaromatic ring system,

Z is a bridge between A and Cp and is selected from the group consisting of



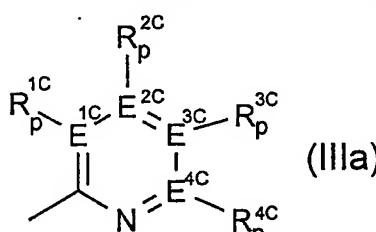
30 where

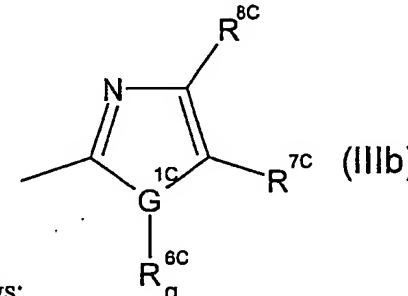
10 L^{1B} - L^{3B} are each, independently of one another, carbon or silicon,

15 R^{1B} - R^{6B} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{7B}_3 , where the organic radicals R^{1B} - R^{6B} may also be substituted by halogens and two geminal or vicinal radicals R^{1B} - R^{6B} may also be joined to form a five- or six-membered ring and

20 R^{7B} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{7B} may also be joined to form a five- or six-membered ring.

25 5. A monocyclopentadienyl complex as claimed in any of claims 1 to 4, wherein A has the formula (IIIa) or (IIIb):

30  (IIIa)

35  (IIIb)

where the variables have the following meanings:

25 E^{1C} - E^{4C} are each carbon or nitrogen,

30 R^{1C} - R^{4C} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{5C}_3 , where the organic radicals R^{1C} - R^{4C} may also be substituted by halogens or nitrogen and further C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{5C}_3 groups and two vicinal radicals R^{1C} - R^{4C} or R^{1C} and Z may also be joined to form a five- or six-membered ring and

35 R^{5C} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals

R^{5C} may also be joined to form a five- or six-membered ring and

p is 0 when E^{1C} - E^{4C} is nitrogen and 1 when E^{1C} - E^{4C} is carbon,

5 G^{1C} is nitrogen, phosphorus, sulfur or oxygen,

R^{6C} - R^{8C} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{9C}_3 , where the organic radicals R^{6C} - R^{8C} may also be substituted by halogens or nitrogen and further C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{9C}_3 groups and two vicinal radicals R^{6C} - R^{8C} or R^{6C} and Z may also be joined to form a 5- or 6-membered ring and

10 R^{9C} are each, independently of one another, hydrogen, C_1 - C_{20} -alkyl, C_2 - C_{20} -alkenyl, C_6 - C_{20} -aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{9C} may also be joined to form a five- or six-membered ring and

15 g is 0 when G^{1C} is sulfur or oxygen and 1 when G^{1C} is nitrogen or phosphorus.

6. A monocyclopentadienyl complex as claimed in any of claims 1 to 5, wherein

20 Z is selected from the group consisting of $-C(R^{1B}R^{2B})-Si(R^{3B}R^{4B})-$, $-CH_2-C(R^{3B}R^{4B})-$ and 1,2-phenylene.

25 7. A catalyst system for olefin polymerization comprising

30 A) at least one monocyclopentadienyl complex as claimed in claims 1 to 6,

B) optionally, an organic or inorganic support,

C) optionally, one or more activating compounds,

35 D) optionally, further catalysts suitable for olefin polymerization and

E) optionally, one or more metal compounds containing a metal of group 1, 2 or

13 of the Periodic Table.

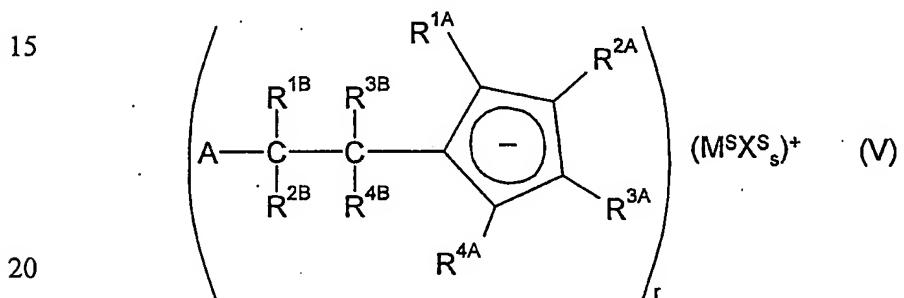
8. A prepolymerized catalyst system comprising a catalyst system as claimed in claim 7 and one or more linear C₂-C₁₀-1-alkenes polymerized onto it in a mass ratio of from 1:0.1 to 1:1 000 based on the catalyst system.

5

9. The use of a catalyst system as claimed in claim 7 or 8 for the polymerization or copolymerization of olefins.

10 10. A process for preparing polyolefins by polymerization or copolymerization of olefins in the presence of a catalyst system as claimed in claim 7 or 8.

11. A process for preparing cyclopentadienyl systems of the formula (V):



where the variables have the following meanings:

R^{1A}-R^{4A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A}₂, N(SiR^{6A}₃)₂, OR^{6A}, OSiR^{6A}₃, SiR^{6A}₃, where the organic radicals R^{1A}-R^{4A} may also be substituted by halogens and two vicinal radicals R^{1A}-R^{4A} may also be joined to form a five- or six-membered ring, and/or two vicinal radicals R^{1A}-R^{4A} are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O and S.

R^{6A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{6A} may also be joined to form a five- or six-membered ring,

A is an unsubstituted, substituted or fused, heteroaromatic ring system,

5 $R^{1B}-R^{4B}$ are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{7B}₃, where the organic radicals R^{1B}-R^{4B} may also be substituted by halogens and two geminal vicinal radicals R^{1B}-R^{4B} may also be joined to form a five- or six-membered ring and

10 R^{7B} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals R^{7B} may also be joined to form a five- or six-membered ring,

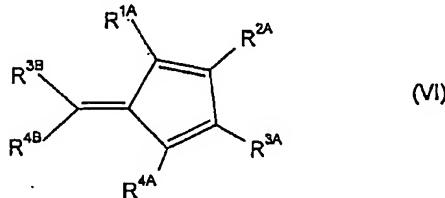
15 M^S a metal of group 1, 2 or 3 of the Periodic Table of the Elements,

20 X^S are each, independently of one another, fluorine, chlorine, bromine, iodine, hydrogen, C₁-C₁₀-alkyl, C₂-C₁₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having 1-10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR¹R², OR¹, SR¹, SO₃R¹, OC(O)R¹, CN, SCN, β -diketonate, CO, BF₄⁻, PF₆⁻ or a bulky noncoordinating anion and

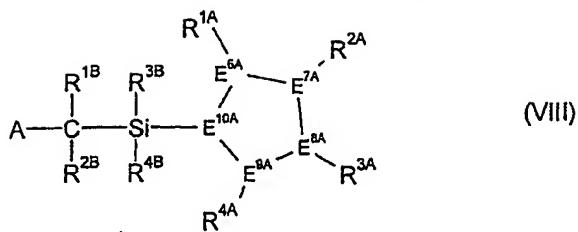
25 s 0, 1 or 2,

 r 1 or 2, with the proviso that s + r is the oxidation state of M^S - 1,

 which comprises reacting (A-CR^{1B}R^{2B}-)_r(M^SX^S)^s⁺ with a fulvene of the formula (VI)



30 12. A process for preparing cyclopentadienyl systems of the formula (VIII):



(VIII)

where the variables have the following meanings:

5 E^{6A} - E^{10A} are each carbon or not more than one E^{6A} to E^{10A} is phosphorus, where four adjacent E^{6A} - E^{10A} form a conjugated diene system and the remaining E^{6A} - E^{10A} additionally bears a hydrogen atom,

10 R^{1A} - R^{4A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part, NR^{6A}₂, N(SiR^{6A}₃)₂, OR^{6A}, OSiR^{6A}₃, SiR^{6A}₃, where the organic radicals R^{1A}-R^{4A} may also be substituted by halogens and two vicinal radicals R^{1A}-R^{4A} may also be joined to form a five- or six-membered ring, and/or two vicinal radicals R^{1A}-R^{4A} are joined to form a heterocycle which contains at least one atom from the group consisting of N, P, O and S,

15 R^{6A} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two geminal radicals R^{6A} may also be joined to form a five- or six-membered ring,

20 A is an unsubstituted, substituted or fused, heteroaromatic ring system,

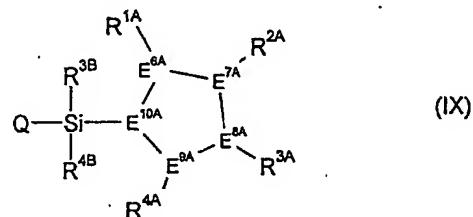
25 R^{1B} - R^{4B} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part or SiR^{7B}₃, where the organic radicals R^{1B}-R^{4B} may also be substituted by halogens and two geminal or vicinal radicals R^{1B}-R^{4B} may also be joined to form a five- or six-membered ring, and

30 R^{7B} are each, independently of one another, hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl or alkylaryl having from 1 to 10 carbon atoms in the alkyl part and 6-20 carbon atoms in the aryl part and two radicals

R^{7B} may also be joined to form a five- or six-membered ring,

which comprises reacting $(A-CR^{1B}R^{2B-})_r(M^SX^S)^+$ with a cyclopentadienyl system of the formula (IX)

5



where the variables are as defined above and

10 Q is a leaving group.